Issues of Organ Donation:
An Interactive Multimedia Program

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Declaration:

I decalre that this subthesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from published or unpublished work of others has been acknowledged and a list of references is given.

Signed: Hsiao-Chi Chen

Date: 4th June 1997

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Abstract

An organ transplant is basically a method which allows organs and tissues to be transferred from one organism to another. Advanced modern medical technology has made this an alternative to save the lives of those who are suffering from end-stage diseases. Although the application of organ transplants has been accepted by the majority, it is, by no means, a perfect practice. Organ transplants were conducted without clear ethical considerations at the beginning, so that a large number of questions and debates surround this technique. In the face of a growing problem of organ donor shortage, however, this is the prime time for many relevant organisations to engage themselves in promoting research and community education on organ transplantation as well as organ donation.

As science communicators, as well as trying to encourage people to support organ donation, we should not avoid telling them the risks and controversial aspects of organ transplants and donation. Community education regarding organ donation should provide sufficient information on both the medical-technical background knowledge and the information about current and prospective public disputes. This will help the general public understand more about both the positive and negative aspects of organ transplantation and therefore reduce their doubts and confusion caused by rumours and myths. It will also offer them the opportunity to discuss, debate, and reflect on their own ethical values at an early stage, and so may help them to

make informed decisions if they are confronted with circumstances that require a decision.

Today's secondary school students are tomorrow's 'general public', who take the major role of the decision maker in society. Allowing them to discuss with their peers the social dilemmas such as biomedical issues in the class room, with the assistance and guidance of their teacher(s), can help them to build rational decision-making abilities as well as understand their society, their world and their present and future roles.

This subthesis includes an interactive multimedia program illustrating an introduction to the basic immunological principles of a kidney transplant. The later section of the program provides some open-ended brainstorming questions related to issues of organ donation. Students are expected to have group discussion with their peers under the direction of a teacher.

Contents

Chapter One
Introduction

Background

Organ transplantation aims at saving the lives of those who are suffering from end-stage diseases. Its practice needs public support by means of national legislation, social policy, public funding, and members of the community who donate their organs. However, organ transplantation is a field with some moral 'grey' areas inside which may make people confused, or hesitate to support it. In the face of a growing problem of organ donor shortage, promoting public awareness of organ transplantation and donation seems more and more important.

Purpose

The purpose of this thesis was to provide a multimedia program designed to help the general public understand more about both the positive and negative aspects of organ transplantation, to offer them the opportunity to debate, and reflect on their own ethical values at an early stage; and therefore to help them make an informed decision if they are confronted with circumstances that require such a decision.

Focus

This thesis has the following components:

1. An analysis of the factors that may affect the public when making a decision concerning organ transplantation and donation.
2. A description of the need for secondary bioethics education.

3. An outline of the reasons for choosing interactive multimedia as the instructional tool for the curriculum regarding organ transplantation.
4. An applied multimedia project which includes a kidney transplant story with some basic medical knowledge, and confronts many issues of organ donation for open-ended discussion.

Limitation of the thesis

Due to the constraints of time, the prototype of the interactive multimedia program has not been fully finished. An evaluation is recommended. Some questions have to be considered when doing any further evaluation: Do teachers feel comfortable using this program? What will be the major problems encountered while using this program? What are the attitudes of teachers and students toward using this interactive multimedia program in the classroom? What is the influence of the communication between students, their peers, and the teacher, together with the general classroom atmosphere during the class and group discussion, upon the efficiency and implementation of the curriculum using this program? What is the significance of the program if the implementation is successful? Can it better equip students to make informed decisions in related circumstances in the future?

Overview of the thesis

In this chapter, the background and purpose of the thesis were briefly stated. The focus was outlined. The limitation of the thesis and questions for future evaluation were also described.

The background literature has three divisions, which are reviewed in Chapters two, three and four.

Chapter Two reviews the literature of organ transplantation and issues of organ donation. Four sections are included: organ donation; organ transplants and organ donation; ethical debates of organ donation; and public participation in debates on organ donation.

Chapter Three reviews the literature of computer interactive multimedia, the use of interactive multimedia in education, and its design issues. Chapter Four reviews the literature of teaching ethics in secondary science classroom. It also provides the teacher some guidelines for conducting an ethics class. In addition, it sets out to answer the question: Why does the author choose secondary school students as the target audience?

Chapter Five gives the reasons why the author chose interactive multimedia as the instructional tool for the applied project. It also illustrates the idea, construction, and navigation of the interactive multimedia program. All these are summarised in Chapter Six.

Chapter Two
Issues of Organ Donation

Organ donation

What is life? What is the line between life and death? Can human life be valued, reserved, or delivered as a 'gift'? These are not just philosophical or religious questions any more, but have become practical issues raised by a remarkable modern biomedical advance: organ transplantation.

The shortage of organ supply

In the last ten years particularly, organ transplants have been accepted as a welcome alternative for the treatment of 'end-stage'[1] kidney, heart, and liver diseases. The availability of 'suitable organs'[2]; however, cannot meet the increasing demand for organ transplants. For example, 754 people received organ transplants in Australia in 1995, while there are approximately 3,000 Australians still on the waiting list and two people are lost each week while they are waiting for an organ donation (Australian Kidney Foundation, 1996b; Healy, 1996, p. 10); seven to nine people in the USA die on the transplant waiting lists everyday (Leslie, 1995, p. 1).

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[1] End-stage disease: life-threatening disease which is progressive, and not responsive to treatment (Health Issues Centre and Association, 1990, p. 25).

[2] Suitable organ: for an organ to be suitable for transplantation, it must be intact, that is not damaged or diseased; for optimal results, it should be removed while the heart of the donor is still functioning (Health Issues Centre and Association, 1990, p. 1).

Factors involved in the shortage of organ supply

The lack of suitable prospective donors

The factors involved in the shortage of donated organs are varied (Prottas, 1994, p. 49; The Australian Kidney Foundation & the Science Teachers' Association of Victoria. 1992, p. 103). First, the source of prospective donors with suitable organs is very limited. The organs we are considering here are not renewable, unlike blood and bone marrow which can be both donated and regenerated. Organs like hearts, kidneys, livers, lungs, and pancreas can be donated only when the donor no longer has any use for them (Prottas, 1994, p. 8). Cadaveric donors are, therefore, a better choice in terms of organ donors. An acceptable cadaveric donor must have been healthy and must have died in a hospital under circumstances in which the diagnosis was total and permanent cessation of all brain activity including the function of brain stem. The heart must have been still beating and the organs still 'alive'. Usually, the death of the suitable donor is caused by homicide, stroke, automobile or other accidents. As we become more successful at preventing death on the roads, however, less people will die in road accidents and there will simply be less organs for transplants (Healey, 1996, p. 17).

Second, an acceptable donor does not mean an prospective donor if she or he did not express willingness to donate their organs before the sudden death. Besides, relatives can make independent decisions and often override the wishes of the dead person.

Refutation by families

Approaching the relatives of a potential organ donor is perceived to be a difficulty. Although the law gives the decisive

right to the donors themselves, as indicated by a donor card, in practice it is exercised by mothers, fathers, children and siblings. Personal willingness to donate one's own organs tells us something about an individual's kindness but very little about the actual supply of organs. For instance, about 90% of the Australian population support organ donation in principle; 33% of the population have indicated willingness to donate on drivers' licences or donor cards; 26% have told their family about their willingness; but only 10.6 per million of the population per year, which is about 0.001%, become organ donors (Healey, 1996, p. 3). The real criterion for donation is the willingness on the part of relatives to donate the organs of a loved one. Families are therefore the decision-making unit in organ donation (Prottas, 1994, p. 50).

> 'As organ transplantation has passed out of the experimental stage, the number of people with end stage diseases seeking a transplant has slowly but steadily increased. The number of donations however, has not increased. Sadly this is not because there are not more potential donors. Various estimates are that anywhere from 60 to 70% of potential donations are either refused by the next-of-kin or are never requested' (TransWeb, 1996a, p. 11).

> 'Australia's donor rate is much less than those of other Western countries...Staff may find it difficult to approach family members to request organ donation when relatives are grieving, considering it an intrusion. This has been cited as one explanation for the low numbers of organs donated' (Health Issues Centre and Association, 1990, p. 15).

The difficulty in approaching the relatives of a potential organ donor does not indicate that they are unwilling to consider the option, but mainly that someone is seeking their loved one's heart,

liver, or kidney at the same time that they are suffering a tragic loss of a parent, spouse, child, or friend. Organ transplantation always involves loss and grief—while one life is saved or improved because of an organ transplant, one life has always been lost.

> 'Members of some families identify themselves as donors but, as distressed next of kin, can easily overlook the issue of organ donation in the face of a sudden death within the family' (The Australian Kidney Foundation & the Science Teachers' Association of Victoria, 1992, p. 103).

In fact, most families have emphasised the need for a family discussion, as well as more public awareness with respect to organ transplantation and donation (especially on the publicly acceptable definition of death with reliable criteria and tests), **before** a tragic event occurs (The Australian Kidney Foundation & the Science Teachers' Association of Victoria, 1992, p. 111).

The following lists the 1995 Australian attitude towards organ donation from a research conducted by ACCORD (Australian Coordinating Committee on Organ Registries and Donation) (Healey, 1996, p. 3):

—Likelihood of organ donation of 'next of kin' if the family member knew that the deceased wished to be a donor

- 86% would consent to the donation
- 7% would not give consent
- 7% did not know how they would react

—Likelihood of organ donation of 'next of kin' if the family member did not know the wishes of the deceased

- 27% would consent to donation
- 53% would not consent
- 20% did not know how they would react

'The difficulty arises when the family has never discussed organ donation and understandably they find it difficult to make a decision during such a traumatic time or they are unwilling to make a decision on behalf of the deceased. Approximately 70% of families agree to organ donation and transplant coordinators believe this figure could be increased if more people had previously discussed the issue and knew the wishes of their next of kin' (Healy, 1996, p. 23).

Misapprehensions

Apart from the emotional distress of the relatives, the reasons for unwillingness of both the public and donors' families include many misapprehensions: an organ donor can suffer; the role and practice of the medical professionals is not understood; there are doubts about the diagnosis of brain death and organ donation; and there are fears about the donation process itself—that the body of a donor will be 'insulted' (Prottas, 1994, p. 65). The first misapprehensions seem to reflect fears that doctors would not try their best to save a willing patient whose family had agreed to organ donation. The latter two imply distrust of the perceived difficult and complicated transplant technique and large medical or bureaucratic institutions, and the worry that one's body or that of the loved one would be disfigured or misappropriated for the purpose of research.

Controversy on organ transplantation

In addition to concerns outlined above, controversy concerning transplantation may also be due to social, religious[3] and cultural views about death. 'The removal of organs may be viewed as disrespectful to the dead. For some cultures and religions the body is required to be intact in order to transcend to the hereafter (Prottas, 1994, p. 10; Health Issues Centre and Association, 1990, p. 11). Some religious beliefs may underpin a view that death is God's will and something that should not be interfered with' (Health Issues Centre and Association, 1990, p. 11). Rumours, myths widely spread by irresponsible media (TransWeb. 1996a, pp. 11-15; Health Issues Centre and Association, 1990, p. 11), the concern about age[4], and controversial bioethical issues may also have great impact on the decision-making process of the relatives, as well as those prospective donors.

A research into public attitudes towards organ donation in 1987 and 1995, conducted by ACCORD (Healy, 1996, p. 1), revealed the main reasons for undecided or negative attitudes of Australians to organ donation:

—In 1987

1. Religious
2. Fear of mutilation
3. The wish to bury the body intact

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[3] Most religions do not object to organ donation, but there is widely shared consensus that decisions regarding donation have to be made by the deceased's family (Prottas, 1994, pp. 10, 58).

[4] When is a person too old to be a donor? It is up to 75 years of age for kidney donation, 65 for heart and liver donations, 55 for heart/lung donation, and the ages between 10 to 50 for pancreas donation (Healy, 1996, p. 25).

—In 1995

1. Fear that the process might upset the family
2. Concerns about being too old for organ donation
3. Concerns that doctors may not try as hard as save a patient if the patient was a potential organ donor
4. Concerns that they may not really be dead

'Public support for organ donation is not a worldwide phenomenon. Many cultures with the technical means of doing organ transplantation are unable to operate a significant program because they lack public support. For example, Japan has mastered the medical techniques, but Japanese culture provides little or no support for the procedures' (Prottas, 1994, p. 10).

Organ transplant and organ donation

Definition and applications

An organ or tissue transplant is a medical procedure in which an organ or tissue is taken from a donor and implanted into another person, the recipient. The procedure can be used to arrest disease and as an alternative to severe disability or premature death. It has been applied to the transplants of skin, bone, corneas, blood, bone marrow, ovary, testicle, nerve, middle ear, small intestine, heart valve, heart, lung, kidney, liver and pancreas...,etc.

The history of organ transplantation

Organ and tissue transplants have a very long history. There are records of skin grafts in 2000 BC in ancient Egypt, although they were generally unsuccessful. Gaspane Tagliacozzi, an Italian surgeon, in 1597, tried to replace noses with skin grafts, although it seldom met with success. Early attempts at blood transfusion were

practiced during the eighteenth century. However, the lack of knowledge about different blood types and their mutual compatibility or incompatibility resulted in charges of homicide and were outlawed later by several European courts. It was not until World War I that blood transfusion was widely used. During the nineteenth and early twentieth century, some remarkable progress on the knowledge and techniques of transplantation contributed to the steady increases in transplants in the twentieth century (The Australian Kidney Foundation & the Science Teachers' Association of Victoria, 1992, p. 133; Lamb, 1990, p. 7).

Skin grafts began in the late 1920s. In the 1940s, corneal transplant operation became routine although it actually began in 1905. Much earlier, in 1902, an Austrian surgeon, Dr. Emmerick Ullman, performed a successful kidney transplant in a dog even though he kept it functioning for just a few days (Lamb, 1990, p. 8). However, the failure of this transplant revealed the problem of rejection. Later, in 1904, Drs. Alexis Carrel and Charles Guthrie, who had developed the technique of suturing blood vessels (Lamb, 1990, p. 8), discovered that successful transplants depend on a close genetic resemblance between donor and recipient. Based on this prior knowledge and experience, the modern transplant era, with transplantation of non-regenerating vital solid organs such as hearts, kidneys, lungs, pancreas, and livers, started in the 1950s (The Australian Kidney Foundation & the Science Teachers' Association of Victoria, 1992, p. 133; Lamb, 1990, p. 8).

Dr. Peter Medawar, winner of the 1960 Nobel Prize, discovered the roles of *antigens* and *antibodies* which was the major breakthrough in understanding rejection. Afterwards, tissue-

typing was developed to examine the donor's and recipient's tissues with the view to compatibility. In 1963, the first successful human liver transplant was performed by Professor T. Starzl. Throughout the 1960s and 1970s drugs were developed to reduce the rejection, but many of these had the unfortunate effect of weakening the recipient's immune system. A major breakthrough occurred when cyclosporin was produced by a Swiss pharmaceutical company in 1983 (Lamb, 1990, p. 9). This drug selectively inhibits the rejection of foreign tissues without damaging immune ability to combat viruses and bacteria. This world-shaking discovery has made a notable contribution to later dramatic improvements on the survival rate of vital solid organ transplants. Furthermore, 'the ability to control tissue marks the transition from the era of transplantation as an experimental therapy to the era of organ transplantation as routine therapy' (Lamb, 1990, p. 9).

Today, as medical technology on transplantation is much more developed, transplants of non-renewable vital solid organs have become more common to treat patients with end-stage diseases, save their lives or improve their quality of life. Success rates for transplants of different organs vary. In Australia, one year kidney transplant survival is over 90% and one year success rates are 90% for heart, 83% for liver, 77% for lung, and 76% for heart/lung transplants. Pancreas transplants for patients with insulin dependent diabetes have been performed in several cases with short-term success rates of 92%, although this is still in the experimental stage (Healy, 1996, pp. 25-27). The procedures for certain organ transplants, such as kidneys and hearts, are more advanced, and their success rates are fairly high. Thus, the limitation on the number of transplants presently being performed is in fact

due to the availability of organs. Liver transplants recently have also stepped into the phase of routine therapy. Patients with diabetes are, however, particularly vulnerable to infection; therefore, transplants of the pancreas, or even kidneys to recipients with diabetes, have considerably lower long-term success rates, and experience complications associated with immunosuppressive drug treatments (Healy, 1996, p. 25; Lamb, 1990, p. 18).

Requirements of a successful organ transplant

The transplant of a human organ is a complex and demanding clinical procedure. Apart from the procurement of a suitable, healthy organ from the very limited source, perfect surgery may be another major factor which determines a successful transplant in the short term. Long-term success is highly dependent on the management of the rejection reaction, a process that requires maintaining a delicate balance between tissue rejection, immunosuppression and infection. A good donor-recipient match in terms of tissue type compatibility, as well as the use of immunosuppressive drugs, have made long-term success more likely, although the complications associated with anti-rejection drug treatment are another serious threat to recipients (Prottas, 1994, p. 7; Lamb, 1990, pp. 15-16, 21). Organ transplants therefore require teams of medical specialists, great investments of hospital time and medical equipment, and long-term management of the immunosuppressive agents.

The need for exploiting the organ source or replacements

Since certain organ transplants with very advanced technology and high success rates, such as kidney and heart transplants, are very restricted by the shortage of organ availability, the number performed can hardly meet the increasing demand.

Exploiting the organ source thus appears a task of top priority for the transplantation system. So far, the major source of vital organs is cadaveric donors with living healthy organs. However, due to the concern about donor-recipient tissue type matching, live donors, who are generally the identical twins, siblings or close relatives, are permitted in some countries (with the premise of doing no harm to the donor), to participate in certain transplants like kidney and liver transplants.

Other attempts are also being made to develop replacements for human organs, or to exploit the scope of organ procurement under the pressure of organ shortage.

Foetal tissue and organs from anencephalic babies are being investigated because of the special size and functions for baby recipients or patients with certain diseases like Parkinson's or Alzheimer's disease. Attempts to utilise organs from non-human sources, such as baboons, chimpanzees or pigs are also under way. Moreover, replacement with artificial implants, for example, artificial hearts, is currently being used, in a limited sense, mostly as 'bridges' to assist survival until a donor becomes available. One major problem of artificial implants is the high incidence of strokes and chronic infection, which has not been overcome (Lamb, 1990, p. 114). Artificial kidneys (the kidney dialysis machine), perhaps the most successful case of artificial organ replacements, constitute a partial success in some respects—they can filter blood well enough to maintain life, but they cannot perform the little-understood endocrine functions of the kidney (Prottas, 1994, p. 8), and some side effects still exist.

Is organ transplantation worthwhile?

In the face of making a decision about whether we should support organ transplantation, encourage organ donation and exploit organ sources, one may have some concerns. There has been no comprehensive evaluation of organ transplants in terms of the medical and social aspects. The issue may be considered from its impact on the recipients, donor families, and the society.

The outcomes for recipients of 'successful' organ transplants include an increase in life expectancy and improvement in their quality of life. For instance, liver and heart transplants save lives; renal transplants provide a new lease of life and can save lives. Even though recipients may experience recurring physical symptoms and the accompanying emotional distress, many of them still perceive their quality of life to be good (Health Issues Centre and Association, 1990, p. 21). In this sense, transplants seem a successful clinical approach. To donor families, learning that many grateful transplant recipients have been given the opportunity of life and a great improvement in life style can be a source of comfort to them during their mourning period. From the economical point of view, an organ transplant is expensive; but compared with the expense of traditional treatment for the patient with end-stage of liver and heart diseases to be in and out of the hospital with slight prospects for survival, an organ transplant appears more cost effective. In most cases a person on dialysis is unable to work, due to ill health and time commitment to the dialysis process. On the other hand, a recipient after a successful kidney transplant may go back to a normal lifestyle and become a productive member of society once again (Lamb, 1990, p. 12).

The following provides a range of details on the cost per patient of an organ transplant. It is dependent on the type of organ transplanted, the clinical condition of the patient and the degree of after-care treatment necessary (Leslie, 1995, p. 33; The Australian Kidney Foundation & the Science Teachers' Association of Victoria, 1992, pp. 107, 115):

—Kidney failure costs $40,000 per year for dialysis treatment at hospital and $21,000 at home or community centre. The current figure for the State of Victoria is $8 million for the treatment at hospital. A kidney transplant operation costs $20,000. The cost of anti-rejection drugs to be taken each year thereafter is $5,000 to $7,000.

—A liver transplant operation costs $75,000 to $100,000. An early transplant can save a great deal of money and return a productive member of our society back to life and family. On the other hand, it can take many patients up to 2 years to die with a liver disease, and still cost the government a similar amount to the operation for the patient to be in and out of the hospital.

—Similar statistics to these for liver transplants apply to heart transplants.

On the other hand, however, the number of people who can benefit from organ transplants is small compared with the rest of the public. In addition, those who need a transplant are already at the end of a disease, that is, the organ transplant cannot fully restore health, but has a life-saving and life-prolonging benefit. The entire transplantation system, therefore, serves only to save the lives of

relatively few extremely ill patients who will be dependent on medical care for the rest of their now extended lives. Furthermore, including the procurement and lifelong aftercare, a transplant is quite expensive, although the organ is donated as a gift. Even without rejection problems and side-effects of immunosuppressive drug treatment, frequent consultation with and evaluation by medical teams are also necessary. In addition, 'many transplant recipients cannot re-enter the work force, and all face high future medical costs and uncertain future health statuses' (Prottas, 1994, p. 159).

The costs of resources from medical systems include: the equipment used, training and employment of the transplant team and theatre staff, laboratory tests and supplies; organ retrieval and transport costs, blood supplies; intensive care and life support for donor body (approximately $2,500 per day) while brain death is diagnosed and arrangements made to retrieve and transplant the organs; on-going medical treatment provided at outpatient clinics, pathology tests necessary for constant monitoring; and the treatment of side-effects of immunosuppressant drugs (Health Issues Centre and Association, 1990, p. 19).

Generally, in Australia, access to organ transplants is not determined according to one's capacity to pay, as most are provided in public hospitals (Health Issues Centre and Association. 1990, p. 19). All this imposes a heavy financial burden on society via direct payment for treatment, insurance premiums for health care, and income support programs.

These aspects of transplants—that they benefit relatively few very ill people and require lifelong after-care as well as vast support from the whole society—are therefore, the source of reservations about public support.

Are organ transplants worthwhile? Your answer to this depends on which side of the issue you are standing—reducing the burden on society or fighting for lives for even a very few ill people. The dividing line is very vague, and there may be no absolutely right or wrong answer. Nevertheless, it is often expressed in terms which lead to the reflection: 'Can we ever put a price on human life?'

Ethical debates of organ donation

Organ transplantation, like many other scientific developments, did not begin with a fully clear system of ethical rules which evolved along with the techniques, to guide researchers (Lamb, 1990, p. 4). Although the success of vital solid organ transplants began the modern transplant epoch, this biomedical development has disrupted the belief that 'death is a momentary event characterised by the simultaneous cessation of all characteristics associated with life' (Lamb, 1990, p. 26); and changed the destiny of desperate individuals with hopeless end-stage damaged organs. It has therefore given rise to many ethical and philosophical disputes.

Organ transplant: experiment or routine therapy?

Lamb (1990) has tried to divide organ transplant history into two eras, the 'experimental' and 'routine' therapy eras, according to

the success rates of transplants. In the initial age of solid organ transplants, because of the immature, high risky techniques, the ethical problems generally focused on whether it was appropriate to conduct transplants as experimental methods on seemingly hopeless incurable individuals. Once transplantation became routine therapy, the ethical problems then drew more attention to the procurement and allocation of organs, although considerable problems concerning experimentation still occur as the transplant program leads into other new fields.

> 'The history of organ transplantation is, at one level, a record of scientific and technical success. It is also a history of anxiety and serious moral questioning, which reflects a dialectical movement between the ethical problems of risky and expensive experiments on one hand and routine therapy using scarce resources on the other' (Lamb, 1990, p. 22).

> 'As greater awareness of the benefits of organ transplantation filters through into the public mind, as a clearer perception is achieved concerning the extent to which transplants of non-generative organs have become part of routine therapy rather than high-risk experiment, so ethical approval of organ transplants is likely to increase' (Lamb, 1990, p. 151).

Live related donors

Early kidney transplants were generally from live donors and restricted to twins or close relatives because of rejection problems. This placed moral pressure on the relatives of patients with kidney disease. Some practical precedents forced the discussion of one's moral obligation to another—'Am I my brother's keeper?', to what extent is one's responsibility to provide bodily parts for others?

Does one who needs an organ in order to live have the right to claim the organ of another being?

Cadaveric donors

Perhaps, in the public mind, a heart transplant is not perceived just as the replacement of a pump and machinery for circulating blood (Lamb, 1990, p. 12), but reveals the moral, symbolic and cultural significance of 'heart'. The full ethical and philosophical implications of the transplant era dawned after the first heart transplant, in 1967, in which the recipient, Louis Washinsky, lived only for a further 18 days. Critics argued that the following world-wide trend of heart transplant attempts was too hasty, and a risky, premature and experimental course in that early heart transplant age when the surgical skill had run ahead of the knowledge about the control of rejection and infection (Lamb, 1990, p. 13).

Cardiac (heart) transplants brought about a discussion on the adoption of cadaveric donation, particularly after high technology medicine complicated the picture of life and death. First, since organs removed from the dead must, if they are to be successfully transplanted, still have some 'life' in them, it seems that the body of the donor should still have some 'life' in it (Lamb, 1990, p. 4). This highlights the dilemmas of the extent to which the endeavour was considered acceptable in order to maintain life—what is the criterion for determining one's death (see Appendix 2.1)? Could brain death be viewed as 'real' death? Problems arose concerning the very nature and value of human life and the tampering with human organs—what are our notions of 'life', 'personhood', 'humanity', and the moral respect according to a living being? Can a human being be valued as a commodity or donate organs as a

gift? Is there any moral restriction to what can be done to the dead? Should appeals to the sanctity of the human body outweigh the interests of those who have an urgent need for bodily parts (Lamb, 1990, p. 1)?

Organ procurement: buying, selling and trading?

Several legal and ethical questions have arisen in the use of both kidney and liver transplants as routine therapy, concerning the possibility that people may offer to sell part of their body.

> 'On 25 December 1983 the following advertisement appeared in the Burlington County issue of the *New Jersy Times*:
>
> KIDNEY FOR SALE
> From 32 yr. old Caucasian
> female in excellent health
> Write to P.O. Box...
> NJ 085
>
> ...Another more ambitious scheme was proposed in 1983 by an American, Dr. H. Narry Jacobs, who attempted to found an International Kidney Exchange, which would buy organs from around the world and sell them at a higher price to those who wanted them' (Lamb, 1990, p. 134).

Nowadays, trading of organs does exist in some countries. People in third world countries are particularly vulnerable to this practice (Health Issues Centre and Association, 1990, p. 15). Although most western countries prohibit trading in organs, under the pressure of organ shortage it is still hard to eliminate the possibility of organ procurement by trading through the world-wide network of organ sharing.

It has been argued that the sale of organs would increase the supply (UNOS, 1993, p. 14; Lamb, 1990, p. 137) and one should have the liberty over his or her body (Lamb, 1990, p. 138). However, can a value be given to organs or bodies? Will it cause decreased respect for life, especially for those of the poor who may sell organs for making a living? What if criminals access the 'organ market'?

Organ procurement: giving or taking?

In the routine therapy age of organ transplants, the means of organ procurement (options for obtaining transplant organs) also calls forth much discussion. Opting-in and opting-out are two major schemes for procuring organs. Opting-in, which is conducted in most of the countries, requires the direct expressed consent of the donor and, almost always, the donor's family. Opting-out; however, presumes consent for organ removal, unless the patient or her/his next of kin express a specific objection previously. This scheme which is presently adopted in Austria, Denmark, France, Israel, Poland and Switzerland (UNOS, 1993, p. 3; Lamb, 1990, p. 141) empowers physicians or coroners to remove organs from a deceased patient who had expressed no prior objection, without consent from the next of kin if there is no refutation raised by the relatives formerly. Opting-out systems thus can avoid the awkward and painful requests for consent which can be cruel to the donor's family when they are grieving. The question is; however, whether it is moral that a patient near to death is viewed as a potential resource of organs, and it is also an affront of human 'altruism' (Prottas, 1994). Besides, it may reveal the disregard of autonomy of the donor's family if ignoring the consent by them while organs of the deceased are about to be removed. Another objection to the opting-out system is that there is no sure way of checking the

'presumption' by previous record of the expressed objection, especially to those disadvantaged groups such as the poor, the uneducated, the mentally retarded, and the legally disenfranchised.

> 'In the USA, a number of states have introduced "required consent" legislation, whereby medical staff are required to approach the next of kin of every patient in whom brain death is established, to request permission to remove organs' (Health Issues Centre and Association, 1990, p. 16).

> 'Programs in Australia are reliant on donors and donor relatives volunteering to donate organs. A "donor card" campaign was introduced in Australia in 1973, providing a means of indicating consent to donate organs. The card has been issued with driving licences, and requires a person to sign a statement consenting to donate organs on declaration of death if they want to donate following death....Consent must be gained from relatives of the deceased, irrespective of whether a donor card is signed' (Health Issues Centre and Association, 1990, p. 16).

Allocating organs

In the face of increasing demand for organ transplants in the routine therapy era, the limited supply of organs means that decisions are being made about who should receive an organ transplant, and therefore who should not receive one. The allocation of organs then becomes one of the dilemmas.

Should the rationing of transplants rest on equity from an egalitarian approach, or a candidate's social worth on the utilitarian's view (Lamb, 1990, p. 129)?

> 'The case for a fundamental egalitarian approach was made soon after the transplant programme began, and it is worth repeating: When mortals are called on to make ultimate choices for life and death among their innocent

> fellows, the only tolerable criterion may be equality of worth as a human being' (Lamb, 1990, p. 130).

The former argued that on principles of equity, anyone who needs a transplant should receive one regardless of cost. However, it is difficult to maintain in actual practice when the truth is that there are not enough resources to go around. As an outcome, 'queue-jumpers' may offer the necessary price for equality and fairness in principle. But if equity is a concern of systems built on 'altruism', such as voluntary donations, people who make a gift of their relative's body would want to know that it will be used in the best possible way (Prottas, 1994, p. 165). Therefore, the practical decisions are in fact made on the basis of the severity of the condition (to ensure the more likely success of a transplant), length of time the person has been waiting, the ability to match available organs, the age of the person, and the stage of the illness (Health Issues Centre and Association, 1990, pp. 16-17); namely, on an 'alternative equality'.

On the other hand, the point based on an utilitarian's view concerns the 'efficiency of investment', so to speak. The social worth of a candidate can be the reference to her/his capacity to benefit society after a successful transplant (Lamb, 1990, p. 129). But how does one weigh up the benefits to society? So far, there seems no satisfactory mechanism to evaluate social worth without being accused of abuse.

Further research and experiments in the routine therapy era

Immunosuppressive drugs are used to reduce rejection, and by raising the success rate of transplants, they led kidney and heart

transplants into the routine therapy stage. However, they bring about other risks by side-effects because of their toxicity, including hypertension, renal exhaustion, heart failure, hepatitis, and cancer. Research and treatments then have to be done in order to resolve side-effect problems of those drugs. Moreover, problems associated with the balance between infection and anti-rejection also cause the need for more research and experiments to find other alternatives. All this implies the turning of the routine transplant therapy into another new 'experimental' stage.

> 'Despite life-saving and prolonging benefits, transplantation of kidneys, hearts and livers do not fully restore health, but "substitute(s) the side-effects of immunosuppressive drugs and a life-long battle against organ rejection for the underlying disease" (New York Task Force, 1988:viii)' (Lamb, 1990, p. 21).

Experimental transplants

In addition to the research on improving immunosuppressive drugs, 'experimental transplants' making use of other alternative organ sources, such as foetal tissue, anencephalic babies, animals, and artificial implants, take the routine transplant era to a new experimental stage. As the 'experimental' age comes, new issues and debates follow. Some view experimental surgery as necessary to expand knowledge and provide advances in transplant procedure. Others argue that it is too expensive, still 'experimental', risky, and raises many ethical problems.

The use of human foetal tissues and organs

Why do foetal tissues and organs create interest? Foetal liver, neuron, thymus, pancreas cells, etc, have special features which are lacking in adult tissues (Lamb, 1990, pp. 70-73). For example, due

to the immaturity of foetal neuron or thymus, there is more potential to develop good substitute functions for old damaged organs or tissues after transplants. Another advantage is that foetal transplants might not be rejected by incompatible recipients as strongly as adult transplants (Lamb, 1990, p. 70), and thus may reduce the risk of rejection and the use of strong immunosuppressive drugs. It has been shown by animal experiments and human clinical trials that appropriate foetal tissue transplants can, in some cases, be used to treat diabetes by recovering normal insulin function, as well as restore brain function of patients with Parkinson's, or Huntington, or Alzheimer's diseases which are currently considered to be irreversible damage or injuries to the brain or spinal cord. However, those experimental achievements can not avoid the ethical debates surrounding the acquisition of foetal organs and tissue.

Foetal transplants generally require foetal organs or tissues up to six weeks of age (May, 1990, p. 986). The foetus in question will be dead prior to dissection. But because there must be no time delay between circulation stopping in the foetus and the organ or tissue being removed, the foetus must not be dead before 'delivery'. That is, the foetus in question will not be one which 'naturally' dies before the abortion. Therefore, those who object argue that, first, the killing and then dissecting a foetus is an abuse to a developing human being (Lamb, 1990, p. 74). Second, the argument for the deliberate termination of pregnancy is wrong and immoral—is it right to kill a foetus for the purpose of removal? Will the adoption of foetal transplants encourage deliberate abortion? Can the use of foetal organ or tissue from deliberate abortion can be morally separated from the abortion itself? (Health Issues Centre and Association, 1990, p. 16). Will foetal transplants lead to the

possibility of a market in selling foetal material? Furthermore, consent to the use of foetal organ and tissue must be obtained before the abortion, and this then adds stress to the woman during an already traumatic time of spontaneous or elected abortion. Another one of the major questions is whether it is worthwhile to practice the dissection of human foetuses while foetal transplant is still in its experimental stage.

Anencephalic baby donors

Tragically, some infants are born as anencephalics[5]. About 100 anencephalic infants are born for every 250,000 live births in Australia. Two thirds of anencephalic infants, with little or no brain structure and functions, are born without heart beat and breathing. Only 25 to 45 per cent of them are born breathing and with heart beat, because of the existing but generally incomplete or malformed brain stem (Waller, 1991, p. 1; Campbell, 1991, p. 12; Lamb, 1990, p. 84).

It is believed that anencephalic infants have no consciousness or awareness (see Appendix 2.2), and are doomed. Without life-sustaining treatment, they inevitably die within hours, days, or, at most, months (Campbell, 1991, p. 12).

Anencephalic infants are considered as valuable sources for organ procurement because, apart from brain malformation, their

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5 Anencephalic infants have a malfunction of the skull and brain, resulting in complete absence of cerebral hemispheres (cortex) and variable absence or abnormality of other brain structures. Whilst they have a brain stem, it is often malformed or functions poorly (Cambell, 1991, p. 12).

other organs are often suitable for transplants, if the circulation is satisfactory. But as long as an anencephalic infant's brainstem functions still works, it can not be used as an organ source (Campbell, 1991, p. 13).

In fact, more and more newborn babies and very young infants (less than three months) are born with unfixable lethal defects of vital organs such as hearts and kidneys. They used to have the same destiny as anencephalics, but can now be treated, and have been treated, by the transplantation of organs from anencephalic infants. Livers and kidneys from anencephalics have also been used successfully in older children and even adults. Some therefore advocate that there is no point in prolonging the life of anencephalics, especially when it could involve much suffering to their parents (Campbell, 1991, p. 13). For some of those parents, organ donation can even give a meaning to their babies' lives; for example, other infants can live for their babies' sacrifice.

However, compared with adult cadaveric and live donation, transplants using brain-absent anencephalic infants are even more morally complicated, and raise more questions. Infants cannot speak for themselves, so how could we be absolutely sure that anencephalic infants cannot experience pain and discomfort? Do their speechlessness and powerlessness mean that their parents, the medical profession, or the wider community have the right to decide whether they should live or die? Clearly anencephalic infants have no hope of benefit, but does lacking the prospect of benefit mean those lives are inherently disposable in the interests of others? What are our ethical and legal duties to such babies?

Actually the birth of an anencephalic infant is preventable—once it is found by ultrasound scans, termination of pregnancy can be offered. For the sake of increasing demand of infant organ transplants, a mother, in such circumstances may receive advice that she continues with the pregnancy to turn this tragedy into a hope which an organ of the anencephalic baby may be salvaged and another child is so given a real chance for life. However, whether it is morally acceptable is still a big issue.

The use of animal resources

Xenotransplants (or xenografts) —using animals as organ donors—have had a controversial history with a bad beginning. In the mid-1660s, attempts to conduct transfusions using lamb's blood were unsuccessful in Europe and banned later as a warning against letting practical skills run ahead of theoretical knowledge (Lamb, 1990, p. 111). In the 1960s, before widespread dialysis and successful human cadaver kidney transplantation became possible, there were several trials of chimpanzee-human, baboon-human kidney transplants. Some attempts on chimpanzee-human heart transplants were performed subsequently but none of them succeeded because of rejection problems. Xenotransplantation became world-wide debate in 1984 when a baboon heart was sewn into the tiny body of a 15-day-old baby Fae, who died three weeks later in the US (Healy, 1996, p. 34; Lamb, 1990, p. 112). None of the subsequent recipients of baboon organs has survived longer than a few months. Transplants using bone marrow of baboons or other primates were also on trial in 1995 to try to restore the immune system of patients with AIDS; and of course, this aroused very broad controversy.

The shortage of human donor organs has grown worse since Baby Fae's death. Therefore, xenotransplantation of vital solid organs is set to make a comeback again as a possible transplant alternative. This time, most hope rests on genetically engineered pigs[6] (Healy, 1996, p. 33). Can it be the answer to donor organ shortage? Will people feel comfortable about receiving animal organs?

There are three major current ethical concerns regarding xenotransplants: the concern about animal 'rights'; the concern about the transmission of dangerous animal pathogens to humans; and the concern about the value of involving considerable funding in this highly experimental trial.

Regarding the 'animal rights' concern, several animal rights movements argue that using animals in experiments is a kind of species discrimination (or 'speciesism'). If we think it is immoral to use unwilling humans as donors of organs or as experimental subjects, why would we accept the use of unwilling animals for the same purpose? There would appear to be not much difference between using animals in xenotransplants and vivisection. Do humans have the power to take a God-like role, and the right to destruct, torment, or change the genetic background of those other sentient creatures? In addition, there is no obvious prospect of benefit for either human recipients or animal donors in this highly risky experimental xenotransplant age; while it could do real harm

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[6] Certain human protein genes which concerning anti-acute rejection are artificially located onto the surface of pig organ cells, so that when the organ is transplanted into a human, the immune system would recognise the organ as being 'human', instead of being 'pig' (Healy, 1996, p. 33).

especially to endangered species like primates. On the other hand, arguments for xenotransplants point out that if we can have bacon for breakfast, eat animals for food, use their skins and other products for shoes and clothes, why is using them to save a human's life any different? Besides, xenotransplant researchers now are concentrating on animals like pigs rather than primates, since pigs come in all sizes, they are cheap, the physiology of their heart, liver, kidney and pancreas is similar to ours, and they can easily be bred in germ-free environment (Healy, 1996, p. 35). Primates, on the other hand, are hard to breed, very expensive, their organs are often too small, there is not enough of them and there is a high frequency of viral infection among them (TransWeb, 1996b, p. 2).

Another one of the biggest worries about xenotransplantation is that animal organs may transmit dangerous pathogens, or introduce new diseases in the future after animal-human transplants. The AIDS virus, for example, is believed to have originated in other primates. There are still many known or unknown infectious diseases, and it is impossible to screen in advance for animal pathogens which have not yet been discovered. Who will take this moral responsibility once those biggest worries come true in the future?

Third, although genetic engineering techniques could make it possible to reduce the chances of rejection in xenotransplants, it is still at a high risk experimental stage. Even though transmitted human genes can protect recipients from acute rejection in the short term, no one knows whether the later, long-term chronic rejection, which strikes even human organs years after transplants, can be prevented. Moreover, these advanced techniques and research cost

considerable amounts of money. Some doubt whether it is worthwhile to put such money into these projects instead of investing in other more sensible and predictable transplant research or exploiting alternative transplants.

In any case, regardless of whether xenotransplantation becomes acceptable, it is certain that new issues raised will continue to generate public discussion in the future.

Public participation in debates on organ donation

Organ transplantation, as one of the more advanced medical practices, is a human endeavour aimed at saving lives or improving the quality of life. However, its practice is influenced by our political, cultural, religious, and ethical values. For instance, organ transplantation and donation can not succeed without public funding for medical research, education, clinical resources and staff training, as well as a positive attitude and support from national legislation, social policy, and members of the community who donate their organs.

Since transplant techniques were conducted without clear ethical consideration at the beginning, organ transplantation is a stimulating but controversial field with some 'grey' areas inside. The general public may be not unfamiliar with information concerning organ transplants, but how much do they understand?

Public attitudes towards the information level on organ donation were researched by ACCORD (Healy, 1996, p. 3):

- 4% of the population feel they are extremely well informed on the issue
- 10% feel very well informed
- 43% feel reasonably well informed
- 30% feel not very well informed
- 12% know very little about it

The public is the legitimate source of authority for all socially oriented decision making (Weeramantry, 1983), but there are so many myths, doubts and unsolvable ethical debates which may make people confused, or hesitate to make the decision—is it worthwhile to develop organ transplantation to save more human lives? Is it moral to encourage organ donation to meet the problem of organ shortage? Is it the right direction to exploit other organ sources such as non-human organ donors? In the face of those dilemmas, how much do the public think they can make a right judgment or better political, social and moral decisions? This highlights the importance of community education and greater need for informed public participation in debates on organ transplantation.

'If, as a society, we do not establish a firm moral and ethical base for such decision making, then any benefit from the developments of medical technology now provided will be lost. If lives are going to be improved, and indeed saved, through transplantation, then the procedures must be morally, ethically and legally acceptable to the majority of the community' (The Australian Kidney Foundation and the Science Teachers' Association of Victoria, 1992, p. 97).

In the next chapter, the literature of computer interactive multimedia, the use of IMM in education and its design issues will be described.

Chapter Three
Interactive Multimedia Programs

Multimedia and interactive multimedia

What is multimedia?

Definitions of the term 'multimedia' are widely varying (Latchem, Williamson & Henderson-Lancett, 1993, p. 1). Basically, it means any communication process which incorporates more than two media (Kanning, 1994, p. 40). In recent years, multimedia has gradually come to mean 'computer multimedia', which combines various types of information (including text, graphics, animation, photographic-quality still images, sound, and full-motion video) on one platform—the computer (Steele, 1989, p. 272). This 'multi-channel' approach reinforces learning and is especially suited to dynamic topics.

What is interactive multimedia (IMM)?

Interactive multimedia (IMM) was generated by advances in computer technology. With it, users become more than just observers, being allowed to control the program actively to stop, start, and/or choose the provided information or media which suit them best or interest them most. (Hedberg & Harper, 1992, p. 10; Steele, 1989, p. 273). The level of interactivity provided to the user is dependent on the purpose of the program and the materials which the designer wants to present (Bennett, 1995, p. 3).

IMM is broadly applied. For example, it may take the form of pure entertainment (some computer games); public information kiosks (public service, tourist service); displaying (exhibitions); demonstrations (industry training, laboratory training); communications (video conferencing, tele-conferencing); presentations (business, conference); marketing (advertising, sales); and education (tutorials, lectures, or distance education); etc.

Interactive multimedia as pedagogy

The use of IMM for educational purpose

To enhance students' learning experience, apart from text and graphics on blackboard or notes, teachers have used audiovisual 'multiple' media presentations such as overhead transparencies, slide shows, tapes, television, video, broadcasts, limited only by technology and facilities which are available. These kinds of aids are still, however, 'controlled' by the teacher.

As early as the 1960s, experts foresaw the impact of the computer on education because of its potential to integrate audiovisual materials (Woolf & Hall, 1995, p. 75). Nowadays, although IMM is still a relatively new means of preparing and delivering learning messages, a variety of IMM courseware products have been produced. The instructional modes include databases, dictionaries, encyclopedias, medical diagnostic textbooks, interactive books, simulations, and so on (RMIT, 1996a).

IMM courseware can empower users to control their own learning, and it can be designed for use by individuals or small groups (Latchem, *et al.*, 1993, p. 21). Learners can work in their own time, at their own pace, and choose their preferred navigational pathways.

Although most of the IMM programs have been designed in the form of an individual tutorial, a few IMM courseware products have recently been created for classroom instruction. They have been applied to many disciplines in school classroom such as language, history, mathematics, physics, chemistry, and biology.

Why use IMM in education?

There are a few theoretical and practical bases for considering IMM as a means of presenting learning materials to users:

Providing learning and motivational stimuli

IMM combines the technologies of 'multiple' media into a single teaching device. It therefore offers a wide range of tools to stimulate the senses and satisfy intellectual needs. For example (RMIT, 1996a):

- pressing hotwords to reveal definitions
- clicking on a picture to probe for further information
- quick links between related topics
- video footage to provide atmosphere or to show dynamic examples
- audio segments to assist those who prefer listening to explanations

- animation to show how things work

For learning to be effective, it is important for the learner to use a range of senses during the learning process (RMIT, 1996b, p. 4). IMM design uses a concerted combination of tactile, visual and auditory stimuli to help arousing the learner's attention and raising their level of concentration. When the learners are more aware of the learning process, metacognitive learning then occurs (RMIT, 1996d, p. 4).

The major advantage of IMM over other audiovisual media is that learners with different learning styles can 'choose between modalities' (within the program design constraints) to suit her/his learning style.

> 'Audiovisual material can provide valuable aids for teaching systems. However, a system is only useful if the learner remains active and motivated' (Woolf & Hall, 1995, p. 74).

Providing interaction with learning material

'Any teaching medium or combination of media used well promotes interaction of learners with the learning material' (RMIT, 1996c, p. 4).

The particular advantage of IMM is that it shifts the emphasis away from verbal learning (spoken and written) and facilitates more

flexible, 'interactive' styles of presentation. Unlike traditional computer-aided learning (CAL), which too frequently uses the computer as a 'page turning' device, IMM not only organises and represents knowledge but gives the users with different learning styles easy access to resource and learning materials in ways that suit them most (Steele, 1989, p. 277). Memory retention and concentration is not a problem as the learner can choose the degree of exposure to the material (RMIT, 1996c, p. 5).

> 'Researchers have known for years that people learn best when they can compare, contrast and interact with ideas and facts, and they're also more likely to retain information if they can access and communicate in their own way. This technology "multimedia" gives teachers a powerful and practical learning environment to take advantage of these concepts in a way they couldn't before (Apple Computer Media Release, 1989, p. 9).
>
> 'Learning takes place by the association of previously unknown phenomena to the known content of a learner's cognitive framework. The assimilation of new stimuli will therefore usually involve the accessing of, and seeking of an association with, the content of a learner's long-term memory. Multimedia presentations offer a rich source of stimuli to facilitate a learner's associative learning in the knowledge and cognitive domains' (RMIT, 1996c, p. 5).

Collecting and providing organised teaching resources

Some well designed educational IMM provide learning materials with which teachers may not be comfortable or may feel difficult to access by themselves, but with which students may readily learn. It also gives teachers previously unobtainable versatility in using

resources with a range of different attributes in the classroom, easily and efficiently.

Making learning fun

One of the advantages of IMM over other media is that it creates a more entertaining learning environment through the use of the 'multi channel' approach. Making learning fun may attract learners' attention, keep their learning motivation and concentration, and can enhance the learning process (RMIT, 1996a).

However, IMM is, by no means, always a perfect instructional tool. It has some limitations. For example (Ferry, Hedberg & Harper, 1996, p. 133; Bennett, 1995, pp. 10-11):

- it may need more expensive facilities than other media
- it does not encourage interaction with other people such as peers or school teachers
- it may lead to further deterioration if the design is poor
- it may need other accompanying instructional media or approaches if the class size is large or student backgrounds are widely varying

<u>When is IMM appropriate for classroom instruction?</u>

The selection of instructional media

Although IMM has many advantages in improving the learning and teaching process, it should not be assumed that this kind of instruction can be successfully applied to every context. Apart from the teaching context itself, selecting a proper instructional medium for

classroom needs to take all constraints (such as the facilities, cost, venue, the number of students, etc) into consideration. Sometimes, other media can be a better choice (Romiszowski, 1993).

Media which can be used for instructional design include printed materials, lectures, audio-tape, slides, overhead transparencies, slides/tapes, television, motion pictures, and simulations. Each of them has its strong features and advantages. A better instructional medium is not necessarily the one with higher, or more complicated technology. The factors which influence media selection include (Romiszowski, 1993):

- subject matter and required student performance
- type of learning task—objectives, context, etc
- target population—size, location, etc
- characteristics of students—age, existing knowledge of the topic, motivation for the study, learning style, skills, etc
- teacher's attitudes, skills, teaching style, etc
- teaching space, lighting, facilities, etc
- practical design constraints—money, time, etc

The proper time of choosing IMM for science classroom instruction

For scientific subjects, IMM can be an appropriate medium to assist learning (RMIT, 1996e, pp. 5-6; Bennett, 1995, pp. 8-9; Latchem, *et al.*, 1993, pp. 21-22). This is particularly true when the learning process requires:

- the learners to consciously control the flow of instruction

- the learners to experience phenomena and events that might be impossible because they are too expensive, too dangerous, or unsuitable for the learners' current competency levels; for example, 'desktop surgery'
- the learners to experience laboratory work that cannot usually be done due to the difficulty, time and high cost
- the learners to experience a 'hands-on' operation or simulation of a real-life event or process; for example, 'pilot training'
- the learners to understand better abstract phenomena that cannot be seen; for example, a chemical reaction or cellular, molecular biological responses

In other words, IMM can achieve the instructional goals by providing 'hands-on' operation, simulation, animation, or communicating three-dimensional information. It is a particularly effective medium for providing opportunities for experiential learning, brainstorming and problem-solving. A good IMM design can encourage deep and meaningful learning, and help the learners to evaluate and modify their schemata (Latchem, *et al.*, 1993, p. 22).

On the other hand, if the IMM courseware and design cannot meet the instructional goals, the context, the learning process, and constraints (such as learners size, the venue, and facilities), one should consider selecting other media rather than IMM.

Designing an interactive multimedia program for instruction

The steps for developing IMM courseware

The development of IMM courseware basically needs the following steps (RMIT, 1996a; RMIT, 1996h):

1. Defining the purpose or goal of the courseware—What do you intend the learners to know and be able to do, after completing the course?

2. Analysing the learners—Who are going to be the potential recipients of the courseware? What is their existing knowledge of the topic, their language skills, and their motivation for this study? Knowing these, you can make the contents and appearance of the program more closely fit their needs. However, IMM courseware is often developed for a large market, so experienced, intelligent assumptions have to be made (RMIT, 1996a).

3. Collecting and gathering resource materials—This is the crucial and the most time consuming step of IMM courseware development. It builds the basis for the text, the script and its appearance, and will influence every aspect of the audience interaction. This step normally requires teamwork by the instructional designer, content expert, graphic designer, authoring coder, sound recordist, and technical coordinator (RMIT, 1996a).

Three types of resources need to be collected for developing an IMM courseware (RMIT, 1996a; RMIT, 1996h, pp. 1-2):

- references and materials in relation to the subject matter: you may adapt some existing authorised text, graphics, audio, and video resources, or produce some resources specifically for your IMM program
- materials for instructional development such as instructional design, manuals, etc
- materials related to IMM development and the type of delivery system that is identified as being appropriate; for example, computer and other medium hardwares, manuals, programming guides, softwares, authoring tools for IMM and graphic design, etc

4. Generating ideas (brainstorming) and organising, sequencing content for the courseware (storyboarding)—Before you really go near the computer or authoring application, your will need to generate and refine ideas about the information presentations, program appearance and style, and instructions by brainstorming with the workteam. Then you need to arrange the resources that you collected (including text, diagrams, graphics, tables, animations, audio and video); design each screen; draft the instructional messages that will be viewed by the learners; and sequence the screens (RMIT, 1996a; RMIT, 1996h, pp. 1-2). There are basically two ways of sequencing the screens: linear and branching. More detailed theoretical sequencing models (the linear, hierarchical, referential, chessboard, and 'Mentor' models) have been reviewed by Bennett, S. (1995, pp. 4-5).

5. Flowcharting the lesson—this helps you to organise the structure or architecture of the courseware. A flowchart is like a map of how the courseware will unfold. Although it does not have to include all the textual and graphic presentations, it should include 'all' the points at which the learner is required to make a decision or is allowed to have interactions (RMIT, 1996a; RMIT, 1996h, p. 3).

6. Programming—This process translates what is on paper (storyboard and flowchart) onto the screen, and provides the learner with a means of navigation through the courseware.

7. Evaluating the quality and effectiveness of the courseware— Before releasing the courseware for public use, the prototype needs to be evaluated concerning its suitability and how well it works. Other instructional designers can help you identify aspects of the program which might need modification. Errors and faults can be found out before the courseware is completed through validation and pilot testing (RMIT, 1996a; RMIT, 1996h, p. 5).

IMM design issues

A well designed IMM program provides the user with a handful of simple ways to travel through screens without getting lost or hitting a dead-end. Linking, user interface design (Latchem, *et al.*, 1993, p. 23), and navigation (RMIT, 1996a) are three important issues in a good IMM design.

Chunking and Linking

Chunking condenses the text into smaller meaningful pieces to fit properly onto computer screen (RMIT, 1996a; Latchem, *et al.*, 1993, p. 23). The chunked text is organised into multiple displays and sub-sets. Visual images (line drawings, graphics, or animations) and sound materials are used to complement the text on each screen.

A link is an association between two items which can be 'turned-on'. The user can activate these links on the computer monitor using the keyboard, on-screen buttons, an active graphic or hot words (RMIT, 1996a; Hedberg & Harper, 1992, p. 12). Creating meaningful and logical links is a real challenge to any IMM courseware developer.

User interface design

The interface of an IMM application influences user's feeling about using the program, and it refers to the 'two-way flow' or interaction between user and computer. Based on information obtained from visual or aural features of the program, the user can make choices or responds to requests which control the next step (RMIT, 1996a).

The effectiveness of a IMM program is dependent on the level of easy-use that the user can apply to all the features on offer, easily and efficiently. Style, consistency, and simplicity are three crucial keys for a good interface design (RMIT, 1996a).

- Style—Style means the way something looks, how it feels to the user and how it is done (RMIT, 1996f, p. 1; Hedberg & Harper, 1992,

p. 12). Your instructional message will be most effective if you choose an interface that is familiar to your audience; for example, a book-, a television screen-, or a computer screen-like user interface. This is called 'choosing the metaphor' (RMIT, 1996a). Once you decide the metaphor, you decide the 'style'. For instance, if the metaphor is a book, you may want page-turning feature; if it is a television, the screen should be full size; if it is a computer, you may use windowing, or scrolling features. The metaphor and the style will affect the user's attention, feeling, way and ability of controlling through the program.

- Consistency—Consistency should be the hallmark of an IMM program. Whatever decisions about interaction have been made by the user, the key element of the program should look and feel the same throughout its entirety (RMIT, 1996f, p. 1). If an interface provides a consistent appearance and consistent responses to user actions, the user can quickly learn the look and the response of each particular type of operation.

  Simplicity—A simple appearance is often most effective when designing a user interface for instructional purpose. Simplicity can be achieved by properly using colour, layout, and limiting number of choices (RMIT, 1996a; Hedberg & Harper, 1992, p. 12).

Navigation

Navigation refers to the ability of the user interactively to control moving between screens within the program. A good

navigation system give users cues about 'where they are within the program, how they got there, what they can do there, where they can get to, what they have seen so far, and what else them can see in the program'. It facilitates the learner's understanding of the learning sequence, and reduce the problems of poor learning (Hedberg & Harper, 1992, p. 12).

Navigation systems use text, icons, windows, menus, scroll bars, colours, etc, to identify the area where the user can have interactions with the program. Instructions should be provided in the program to show users how to use the navigation system. It cannot be too brief or so detailed that it frightens and confuses potential users (Ferry, *et al.*, 1996, pp. 133-134). IMM courseware will almost certainly fail without clear, proper, concise, and accurate instructions for learners (RMIT, 1996g, p. 6).

Instructions are especially important to IMM classroom courseware. Kanning (1994) pointed out that 'ease of use' is one prime concern for teachers when choosing classroom instructional technologies. Effective users of technologies can enhance the learning efficiency and effectiveness of their students. In other words, no matter how well an educational program is designed, especially the one created by computer IMM which is a fairly new instructional technology, without clear guide and instructions it may be used in ways that do not improve the education, but lead to further deterioration (Ferry, *et al.*, 1996, p. 133).

In conclusion, it is not enough to just provide the hardware and software to the IMM user (either the student or the teacher). When designing IMM classroom courseware, designers should provide sufficient support materials to assist teachers in reducing the time and effort required to employ the technology, and effectively using the courseware in teaching.

In the next chapter, the literature of teaching ethics in secondary science classroom will be reviewed. Some guidelines for teachers to conduct an ethics class are also provided.

Chapter Four
Ethics in the Secondary Science Classroom

Science and technology, ethics and secondary science education

Science and ethics

The controversial aspect of science

Science is a human endeavour aimed at improving the quality of life. It was seen by some as being objective, and value-free (Dawson, 1996, p. 15). However, as there has been a 'knowledge explosion' in science in the past 15-20 years, the ethics and social responsibility of its practice have begun to be questioned by society (Van Rooy, 1994, p. 24). In the biomedical field particularly, the moral obligations appear most obvious. Medical decisions are often immediate life and death decisions or are the ones that influence life processes (Skamp, 1986, p. 52). The ethical concerns of some biomedical research are therefore in the forefront of public debate.

Who should make the ethical decisions concerning science?

Making ethical decisions about the use of scientific capability or, if possible, the practical resolution of controversial issues in science is the responsibility of all members of society (Van Rooy, 1994, p. 24; Skamp, 1986, p. 52). What decisions are to be made depend on what kind of science and society we want.

> '... what sort of science we want depends upon what sort of society we want. What sort of society we want depends in turn upon what we think people are for' (Birch, 1978, p. 366).

Weeramantry (1983, p. 24) has argued that scientists, lawyers and judges, and the general public are three groups of people who are necessary to make ethical decisions at the science/technology and society interface. Secondary science education is the obvious arena in which **tomorrow's public** can be introduced to ethical thinking (Skamp, 1986, p. 53).

Introducing ethics into the secondary science classroom

Science education has been focusing on the 'laboratory-oriented method' as a major problem solving technique (Dawson, 1996, p. 15). However, students will need to make political, moral and social decisions for themselves and others in the years to come. They will need to be well-informed about scientific advances and about relevant controls over their development as well as possessing the skills for resolving related ethical problems. Science teachers, therefore, have an obligation to help students develop the ability to evaluate ethical issues that arise from the application of science and technology (Dawson, 1996, p. 16; Van Rooy, 1994, p. 24; Skamp, 1986, p. 51). The Australian Education Council identified one of the goals of science education as the need to equip students to 'make decisions that include the ethical consideration of the impact on people and the environment of the processes and likely products of science' (Australian Education Council, 1994, p. 5).

There are some bioethical issues which arise within the prescribed content areas in the national science curriculum for secondary schools (Australian Education Council, 1994). For instance, the Year 11 Human Biology curriculum in Western Australia contains sections on organ transplantation, surrogacy, euthanasia, abortion and genetic abnormalities (Dawson, 1996, p. 16). Dawson expressed her worry: 'If science teachers ignore ethical dilemmas which inevitably arise in science, students are likely to receive the implicit message that there are no dilemmas in science' (p. 16). It is believed that introducing controversial scientific issues in the classroom may enable students to view science not just as fixed objective facts and theories, but as a stimulating, controversial, and changing field (Dawson, 1996, p. 15; Van Rooy, 1994, p. 24; Skamp, 1986, p. 51). All these authors pointed out the importance of teaching science-related controversial issues in classroom.

In summary, science is not an isolated field, it is highly relevant to society and everyday life. In order to provide students with broader and correct views and the ability of judgment to science related issues, secondary science teachers should introduce their students not only theories and technology, but stimulating, controversial aspects as well.

Teaching an ethics class

The aims of teaching an ethics class

Everyone has views about which things are acceptable and which are not. None of the students will come into an ethics class with a completely blank mind (The Australian Kidney Foundation & the

Science Teachers' Association of Victoria, 1992, p. 1). For an effective ethics class design, concentrating on what students think can be better than having students memorise and regurgitate the thoughts of various moral philosophers (Prager, 1993, p. 32).

The aims for an ethics class include:

- helping students figure out their ethical principles and their guidelines for living
- allowing students to look at issues from all perspectives
- helping students to develop their own views based on rational reasoning
- encouraging students to express their own opinions
- helping students to reflect on their own ideas and values by comparing their views with the views of others
- helping students to refine a personal position on certain issues, even if that position is one of uncertainty
- encouraging students to value thoughtful changes of opinion, ideas or beliefs

(Van Rooy, 1994, p. 25; Prager, 1993, p. 32; The Australian Kidney Foundation & the Science Teachers' Association of Victoria, 1992, p. 1)

In order to have effective results, Van Rooy (1994, p. 25) proposed some guidelines for teachers. She suggested that teachers must be honest in their presentation of controversial issues, remain objective and unbiased towards all currently held views, and provide a rational, logical and unbiased methodology for students to use when dealing with those issues. For classroom interactions, she suggested

that both students and the teacher should respect each other's dignity, integrity and self-worth, and must separate their intellectual responses from their emotional responses.

Some student-centred teaching strategies for an ethics class

Before choosing an effective teaching strategy for an ethics class, teachers must decide what they want to achieve through the proposed strategy.

Because the subject matter here involves some questions of value which are open to wider interpretation and greater differences of opinion, and because it demands understanding and reasoning rather than just memorising, the teaching objectives will include (Killen, 1993):

- enhancing students' motivation
- engaging students actively in learning
- increasing students' depth of understanding of course content by exploring it and discussing with other students
- developing students' thinking skills
- improving students' problem solving skills
- developing students' positive attitudes towards handling of the course content
- providing students with an opportunity to apply their knowledge and to see that their knowledge has some real world applications

The followings are some teaching strategies which can be suitable for teaching an ethics class.

Discussion

Discussion is a popular and flexible teaching method for a variety of learning situations. Based on Killen's (1993, pp. 3-4, 8) suggestion, a structured discussion can be a suitable teaching strategy for an ethics class because discussion involves students actively in learning; motivates students through participation; develops students ability to analyse and express ideas orally and thus enhances their thinking and communication skills; allows a sharing of the knowledge and experience of the students; gives students practice in dealing with controversy; and develops problem-solving and critical thinking skills.

Small group work

Killen (1993, p. 24) stated that when use it effectively, small group work has advantages like motivating students, helping students to learn respect for each other's opinions, allowing students to experience a range of social contacts, teaching students to be less reliant on the teacher and more reliant on their own ability to think, and encouraging students to verbalise their ideas and feelings. This can help them to understand the subject matter, by enabling students to look at problems from several perspectives.

Small group discussion has been reported as an effective method of learning (Gooding & Stacey, 1993; Solomon, 1991). This is also an effective way of reducing persistent misconceptions by allowing students to expose their misconceptions and begin to resolve them through discussion (Gooding & Stacey, 1993). Moreover, it develops communication, listening and organisational skills necessary for

decision making and is therefore a possible teaching strategy for handling controversial issues (Van Rooy, 1994, p. 27).

> 'For deliberation about one's own position and the predicaments of others, small group discussion seems to be the most likely way of learning...students could organise their own talk without misplaced controversy that they had views which they were prepared to share with their friends on a wide range of topics, and that these views were often rich with *ethical and social feeling*' (Solomon, 1993, p. 33).

> 'Individuals may develop their moral reasoning by engaging in discussions of moral problems...Students need the opportunity to confront difficult decision-making situations; they need to endorse a position and to think about their reasons for selecting their positions; and they need to hear the reasoning used by others on the same problem' (Galbraith & Jones, 1976, quoted in Prager, 1993, p. 32).

Problem solving

A problem is a question that presents an acceptable challenge which cannot be solved by a routine procedure already known to the student. It also can be a situation where the student must use one or more solution strategies to answer a question or make a decision (Killen, 1993, p. 49).

The problem solving approach provides students with an opportunity to apply their knowledge, helps students to develop new knowledge for themselves and to feel responsible for their own learning. Real-life problems can help students to integrate the knowledge they gain from studying several different subjects.

Moreover, problem solving is often well suited to computer aided instruction (Killen, 1993, p. 48).

If the teacher is taking a constructivist approach in particular (Dawson, 1996, p. 15; Killen, 1993, p. 50), students can improve their problem solving skills by working in pairs or small groups. When students are allowed to work in pairs it encourages them to develop explanations which are meaningful to someone else (Killen, 1993, p. 50).

Other classroom techniques

Some other classroom techniques may also be used to teach controversial issues and help students develop their decision-making skills (Van Rooy, 1994, p. 26). For example:

- developing case studies which closely resemble real-life situations
- using documented case histories—asking students to compare the decisions of the case with their own viewpoint
- developing scenarios—raising further questions and asking group members to apply their decisions to other more difficult situations

Handling an ethics class

Simply putting students in pairs or groups, or giving them a task and asking them to discuss or solve problems, cannot ensure better learning than traditional 'chalk-and-talk' (Gooding & Stacey, 1993, p. 41). There are several important tips for teachers to use to effect a better learning outcome. These include:

- providing students with adequate background knowledge on the topic issue or having them gather related information from the library or other sources before the discussion (Gooding & Stacey, 1993, pp. 47, 49; Aspy, Aspy & Quinby, 1993, p. 22)

- providing students with a decision-making model which sets out the problem(s); presenting accurate, up-to-date objective information on all aspects and then asking students to formulate their own ideas (Van Rooy, 1994, p. 26)

- keeping a low profile while students are engaged in discussion; here the teacher only initiates and facilitates discussion without interfering with students' conceptualisation of ideas and opinions

- encouraging students to give elaborated explanations of their views to help one another in discussion. this is a critical feature of learning during peer interaction (Gooding & Stacey, 1993, p. 41)

- maintaining a positive classroom environment in such a way that no student dominates the discussion (Van Rooy, 1994, p. 26); it can be achieved by avoiding placing students with a wide range of prior knowledge together, or placing students with low prior knowledge together. Research data shown by Gooding and Stacey (1993, p. 43) indicates that in tasks which are difficult and need conceptual reorganisation or problem solving, high and medium ability students worked profitably together as did medium and low ability students

There are quite many strategies for effective classroom teaching. Student-centred teaching approaches are considered to be the most effective ones for an ethics class. The teacher should consider the number and background of students, classroom facilities, the learning content, their own teaching style, and the purpose of their teaching, in order to choose a most suitable approach.

In summary, as Van Rooy (1994) pointed out, teaching ethical issues in science education is an opportunity for science teachers to show their students that science is dynamic, exciting, controversial and highly relevant to their world rather than just a collection of undisputed data which seems irrelevant to them. This especially applies to secondary school students, because even though most of the them will not enter careers which directly or indirectly involve science, they still need to be scientifically informed, and have the capability to direct the future of science and its place in our society. The more understanding of every aspect of science by students, the better judgement of the relationship between science and society they will have in the future.

Therefore, teaching ethics in science classroom is not merely a stimulating innovation in science teaching, it is also a science teacher's obligation.

Teaching ethical issues in organ transplantation

The topic of human organ transplantation gives rise to a number of ethical issues and therefore provides a rich source of dilemmas for

students to discuss. There are a number of educational materials, developed by some organ transplant organisations, for the general public. A few of them are designed as resource materials for secondary schools. The Australian Kidney Foundation and the Science Teachers Association of Victoria also have designed a series of educational materials. '*Transplantation: The issues*', which consists of a video tape and a book, provide rich references and good guidelines for teaching transplant technology as well as the related ethical issues for secondary science classes.

Dawson (1996) designed a unit for students in Year 10 on the topic of human organ and tissue transplantation using these resource materials. In this unit, she adopted some teaching strategies which were undertaken from a 'constructivist approach' (Dawson, 1996, p. 16).

Her first research finding, based on pre- and post- questionnaires, demonstrated that (1) the attitudes of students towards the topic of transplantation are likely to be favourable after studying the transplantation unit, and (2) most students were better able to make a decision regarding transplantation issues after completing the unit. A second research finding was based on the result of teaching strategy evaluation, and suggested that 'student-centred' teaching strategies (such as role-play, group discussion with peers or the teacher, and video materials combined with activities) are likely to be most effective in enabling students to reflect critically on and modify their understanding of ethical issues. However, Dawson also pointed out that the style of the teacher, the nature of students and the dynamics of

the classroom environment are all factors which can affect the effectiveness of a strategy (p. 19).

There are many resources regarding transplantation issues which can be found in journals, books, or internet. Several educational programs on this topic have been developed; many consultants, or bioethicists are available in transplant centres, foundations and organisations; some teaching strategies on this topic have been set up and evaluated; and controversial issues on organ transplantation are now ready to be introduced into the bioethics classroom.

In conclusion, teaching ethical issues in organ transplantation (not just its good aspects) to young students has been considered as a crucial matter by a few organ transplant promoting units. Some research and evaluation have also been done regarding teaching this subject matter in classroom. However, all these also need science teachers' awareness and cooperation. Here a good communication between those transplant units and teachers, as well as the teacher and students, is important; and using proper teaching strategies in this subject matter will be the key for a better learning for students.

In the next chapter, the idea, construction, and navigation of an applied interactive multimedia program will be described and illustrated.

Chapter Five
Program Description

Choosing IMM for classroom instruction about organ transplantation and donation

The aims of the program

The program aims to provide students with an opportunity to develop and reflect their own views on the issues concerning organ transplantation and donation through discussion with their peers. As explained previously, for effective learning, discussions in pairs are recommended (Killen, 1993, p. 50)

Why choose IMM as the mode of classroom instruction for this subject matter?

An IMM program was selected to be the medium of classroom instruction. Apart from the advantages of IMM for classroom instruction (see 'IMM as pedagogy' in Chapter Three), IMM was chosen in order to help the teacher provide students with adequate background knowledge, to motivate students to engage in problem solving, and to establish an 'appropriate classroom climate' that conforms with the effective teaching tips recommended by Killen (1993, p. 50).

Providing background knowledge in organ transplantation

Background information in organ transplantation includes some biomedical terms, complex technology and basic immunological principles. These may be too abstract or difficult for secondary school students to understand if the teacher presents the knowledge using

other media like lectures, overheads, slides or books. Animation is the most special and powerful feature which empowers IMM to demonstrate clearly how things work. IMM is also able to provide a convenient, handy cross-referencing system which allows students to access different sections of the program at any time.

Motivating students to engage in problem solving

IMM provides audiovisual media in one platform and allows students interactively to control the learning process as mentioned in Chapter Three. This feature assists students learning and motivational stimuli, increases their concentration, enhances their memory retention, improves their reflective thinking, and creates an interesting, entertaining learning environment, all of which are important for students effectively to engage in problem solving discussion, as explained in Chapter Three and Four.

Establishing an appropriate classroom climate

In this IMM program, a story (see 'A transplant story' in the program) was designed. It introduces the biomedical issues related to the topic, in a manner designed to improve students' prior knowledge, provides students a chance to develop their own ideas and views, and equips them actively to participate in later discussion.

The story also creates a real-life like situation which is designed to make the scientific theme highly relevant to the real world and students' lives. This can increase students' motivation (Perrone, 1993, p. 11; Stepien & Gallagher, 1993, p. 26), because they may realise that they could encounter similar circumstances one day.

In addition, this IMM program synthesises opinions from several perspectives concerning the issue of organ donation, which are presented through cartoons (see the 'Brainstorming' section in the program). These aim to create the feeling for students that these issues can be raised and discussed on their streets, and in their everyday lives.

The development of this program

This IMM program was developed by the following steps:

1. Defining the purpose of the program—for the use of teaching transplant ethics in science classes
2. Defining the target users—secondary school students and teachers
3. Collecting resource materials—gathering from books, journals, newsletters, newspapers, the internet, brochures, video, CD-ROM
4. Designing the structure and storyboarding
5. Designing the interface and navigation—a combination of a book- and a computer screen-like interface was chosen
6. Writing texts, and creating images, and graphics
7. Authoring and computer programming
8. 'Debugging'

The computer hardware and software which were used in developing this program include:

<u>Hardware</u>

Computer: Apple

Apple PowerMac 7500/100, 33MB RAM/1GB hard disk

Iomega Zip(100) drive/100MB disk

Scanner: Apple Colour OneScanner

Authoring software

IMM/graphing: MacroMedia Director 5.01

Image manipulation: Adobe Photoshop 3.0

Text: Microsoft Word 6/Excel 5

SoundEdit: SoundEdit 16 1.0.1

Scanner software: Ofoto

The program: journeying through an organ transplant

The storyboard

This program consists of four main parts: the kidney transplant story, the Brainstorming section, the Instructions and the Glossary (see Appendices: Figure 1).

The structure of this program is a combination of the hierarchical (the whole landscape—which clearly divides the information into distinct sub-sections), branched (the main story—which is easy to follow but offers space for users to explore and make choices), and referential (the linkage of the glossary and the story—which allows users to explore information according to their interests) structures.

The kidney transplant story

The kidney was chosen to be the organ transplant model in this program, because :

- Kidney transplants have the highest success rates, the highest number performed, but the highest number of patients who are on

the waiting list compared with other non-regenerated vital organ transplants.

- A kidney transplant can be donated by living donors, which provides richer controversial issues for discussion. For example, students must consider organ selling, organ trading, or the moral obligation to the patient's family.

- Other than having a kidney transplant, patients with kidney failure may choose an alternative treatment—dialysis. If the kidney transplant fails, the recipients are able to go back dialysis and /or wait for another kidney transplant.

The story introduces some biomedical science (kidneys, kidney functions and kidney diseases) and technology (replacement therapy for organ or tissue failure, dialysis, and kidney transplants); basic transplant immunology (immune system, HLA (Histocompatibility Locus Antigens), tissue typing, rejection, infection, and immunosuppressants); and social issues (organ procurement, cadaver donation and live donation).

Other than teaching the issues of organ transplantation, the teacher can apply some parts of this program in other scientific classes; for example, the kidney anatomy, dialysis, or immune system screens.

The 'Brainstorming' section

This section collects several ethical issues concerning organ donation and transplantation, and presents related opinions from

various perspectives (from high school students, a doctor, a lawyer, an anti-scientist, an organ donor's or prospective donor's family, prospective recipients and their family, and people from different religions or cultures. The issues include:

- Is organ transplantation worthwhile?
- Cadaveric donation: brain death
- Live donation
- Organ procurement—'taking or giving?' and 'buying, selling and trading'
- Organ distributions—four cases are provided
- Experimental transplants—'foetal tissue and organ donation', 'anencephalic organ donation' and 'animal donors'

Students can choose to start their exploration of the program with either the story or this section. They are strongly recommended, however, to go through these two sections before they participate in the group or pair discussion. These two sections can provide adequate knowledge for students confidently and actively to engage in discussion, with enhanced learning outcomes.

Teachers can choose any of the issues provided in this section for students to discuss. For a better outcome in problem-solving learning, however, it is recommended that they choose no more than two issues (but not necessarily the same topic) at one time for each group or pair to discuss (Killen, 1993, p. 50).

The 'Instructions'

Instructions are important to any IMM courseware (see Chapter Three). These provide the guide for users to allow them maximum experience of the program.

This section introduces the navigation systems of the program including the navigation buttons, icons, text, and the map. The map is offered to give the users a clear idea about where they are, what they have seen, and what they can explore in this program.

The Glossary section

The 'Glossary' provides both the teacher and students easy access to the information and references regarding this program.

Teacher's guide

A teacher's guide will be provided to give the teacher suggestions about 'how to use this program effectively to help students' learning, and 'how to use this program to conduct an open-ended discussion'. This teacher's guide has not yet been prepared. Other more detailed information on the issues of organ transplantation and donation, and ethics class teaching for teachers, can also be found in Chapters One and Four of this thesis.

Chapter Six Conclusion

The shortage of organ supplies for organ transplantation makes the promotion of public awareness of issues in organ transplantation and donation more and more critical (Healy, 1996, p. 3; The Australian Kidney Foundation & the Science Teachers' Association of Victoria, 1992, p. 111). This implies the need for good communication between transplant research groups, teams, organisations and the general public.

This thesis has described the importance of introducing both the positive side (the advanced transplant science and technology) and negative side (ethical debates) of transplantation to young students. An interactive multimedia program has been developed as a supporting instructional medium for teaching this subject matter in the secondary science (ethics) classroom. Peer discussion in groups or pairs is recommended.

This IMM program can be used not only in the classroom, but for individual tutorials. The limitation of using this program is the requirement of a computer facility with CD-ROM drive and in-built speakers. For better performance, a computer with higher RAM is recommended.

A further evaluation of the learning outcomes, and the impact of this program in terms of promoting public awareness of organ

transplantation and positive attitudes towards organ donation is recommended.

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Appendices

Appendix 2.1 The criteria for determining death

In the past thirty years, advances in medical technology have forced changes in medical, ethical, and legal concepts of death. What is the criterion of determining death today?

Cardiopulmonary or traditional death

This means death of a person because of his or her heart and lung (pulmonary) functions have permanently ceased. It was the only model of death before high technology medicine complicated the picture, and still remains most people's experience of death, since most people still die 'naturally'.

Recently, the concept has grown of death being the end of a conscious, feeling person—a human identity. Modern concepts of the person believe consciousness and personal identity reside in the brain, not the separation of the soul from the body as the religious view of death. Therefore cessation of heart and lung function is seen as important only because they always cause permanent cessation of brain function.

Recognising traditional death is easy. It is the absence of heart beat, pulses and breathing over time, followed by signs of bodily decomposition. There is no urgency about the diagnosis of cardiopulmonary death when life-support systems are not involved and organs do not have to be removed quickly for transplantation.

Whole brain death (brain death)

This means death of a person because their whole brain—cortex and brain stem—is dead. 'Whole brain' death, does not mean that every last scrap of brain tissue is dead. Rather it means that sufficiently extensive areas of the brain are so badly damaged that the brain 'as a whole' can no longer maintain bodily survival.

Since the cortex is dead, consciousness and personal identity have permanently ceased. Since the brain stem is dead, breathing has permanently ceased and integration of vegetative functions is lost (heart rate and blood pressure control, temperature regulation, and some hormonal control are lost), meaning that death of the rest of the body is imminent. Since breathing has permanently gone, whole brain dead people are dependent on mechanical ventilators. Blood circulation and other bodily functions will cease immediately if the ventilator is stopped.

Some appear to accept brain death as death of the person because it involves permanent loss of consciousness, that is, cessation of personal identity. Others appear to accept it because it is a certain harbinger of imminent somatic death (that is, a certain indicator of approaching traditional death). Others appear to accept it only because it includes both cessation of the person and imminent somatic death.

Formal confirmation of the diagnosis can be done by a set of clinical tests performed at the bedside. Sophisticated tests can also be done to add proof, including special x-rays—angiograms and nuclear scans—to show that blood circulation within the brain has ceased, and

tests—EEG, electro-encephalogram—to show the electrical activity of the brain has ceased.

Whole brain death must be diagnosed and confirmed by two doctors of appropriate seniority and neither of them can be involved with transplantation of organs. When whole brain death has been demonstrated, the 'person' is legally and morally 'dead', and organs can be removed for use in transplantation if consent is offered.

Brain stem death

This means death of a person because their brain stem is dead. In almost all 'people' whose brain stems are dead, the rest of the brain is dead as well; that is, they have whole-brain death.

Death of the brain stem means permanent loss of consciousness (personal identity) since the brain stem switches consciousness on and off in the cortex, and imminent somatic death. Its practical outcome is thus the same as whole brain death.

These two entities in the brain death debates—whole brain death and brain stem death—can be confusing. Conceptually they are the same. They vary in the technical medical tests and criteria considered necessary for their verification. Arguments about which approach to prove brain death is better are technical arguments, not conceptual.

Cortical death, neocortical death, higher brain death

Unlike whole brain death or brain stem death, these terms have no 'official' recognition in medicine or the law. They refer to death or

extensive irreversible damage of the brain cortex, with preservation of the brain stem (and other brain structures).

Death (or extensive irreversible damage) of the cortex means consciousness and personal identity have permanently ceased (as in whole brain death). But since the brain stem is not seriously affected, the person can still breathe with no need of a mechanical ventilator; and since brain integrative functions are intact, long-term (perhaps for years) bodily survival can be expected.

Long-term 'survival' with permanent loss of all consciousness, awareness, and responses to the environment, is called the persistent vegetative state (PVS). The 'person' is permanently unaware (personal identity has ceased) but breathes successfully. The eyes may be open and wandering some of the time. Random facial and body movements, and movements in response to pain are present in some patients, but they are 'automatic'—not due to awareness or consciousness of sensation. PVS patients have no sensation of hunger or thirst and cannot eat or drink. They are incontinent. Survival therefore depends upon nursing care, including stomach tube feeding.

Many believe that cortical death should be considered as equivalent to (whole) brain death—that is, legally and morally, death of a 'person'. This is because it is seen as being the permanent end of a personal identity as far as 'the person himself or herself' is concerned. Consciousness and awareness are permanently lost, and this, it is argued, is equivalent to death.

If this view were accepted, there would be no legal or moral requirement to continue nursing care, including food and water through a stomach tube. Without food, water and nursing care, a cortically dead 'person' would cease to breathe (and heart would stop) after 2-4 weeks.

There are no universally agreed or validated tests for cortical death. Absence over a long period (months) of all signs of consciousness and awareness would be good positive evidence.

—Campbell, N. (1991). Some anatomy and physiology. In: K. Sanders & B. Moore (Eds.), *Anencephalics, infants and brain death treatment options and the issue of organ donation: proceedings of Consensus Development Conference, February 28– March 1* (pp. 7-18). Melbourne: The Law Reform Commission of Victoria.—

Appendix 2.2 Is a live anencephalic infant analogous to a brain dead adult ?

Some argue that anencephalics born alive are analogous to adults with brain death, and therefore they are considered as valuable sources for organ procurement because, apart from brain malformation, other organs are often suitable for transplants (Campbell, 1991). In practice; however, some anencephalics are not exactly like brain dead adults. Certain behaviours suggest that they are 'seemingly' conscious, aware and 'being alive', because of their still functioning brainstem operations such as breathing, spontaneous movement, movement in response to pain but without awareness of pain, facial grimacing which may resemble smiling, blinking, coughing, sneezing, and even crying. Although allowing an anencephalic baby natural death is routine in many hospitals, it cannot be declared brain dead and used as an organ source as long as the signs of brainstem functions are still present.

There are several conditions in more and more newborn babies and very young infants (less than three months), the outcomes of which could be improved by transplantation of new organs if they were available. Whilst, transplant teams have to wait until an anencephalic infant's brainstem functions cease (breathing and circulation stop) but this will usually mean organs are spoiled from loss of circulation and oxygen supplies. Therefore, some arguments from a utilitarian point of view, suggest redefining the meaning of the 'death' of anencephalics.

—Reference source: Campbell (1991); Lamb (1990)—

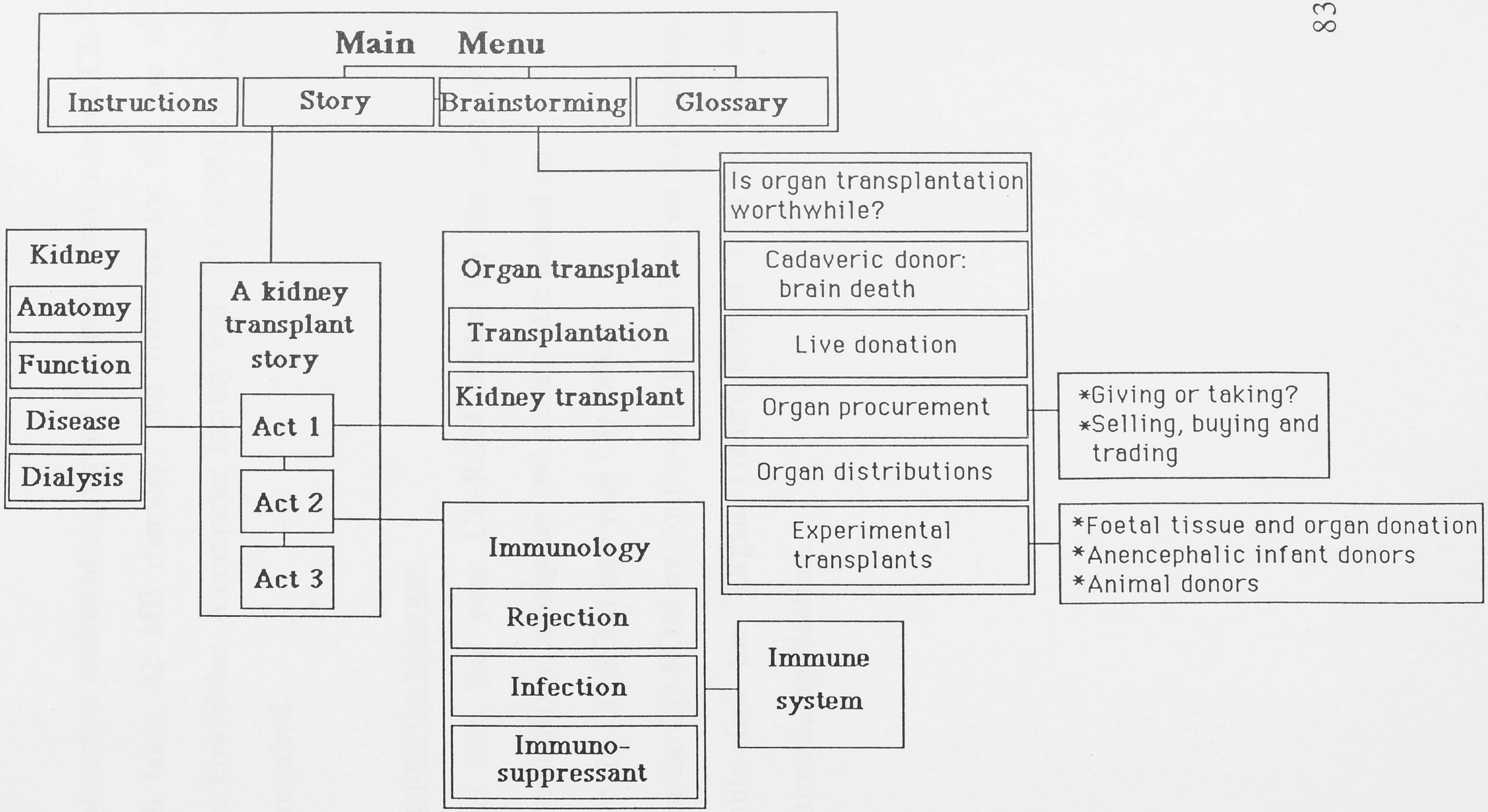

Figure 1 Storyboard

Installation instructions

The interactive multimedia program has been written into a CD-ROM which takes 42 MB memory, and formated for the use of Macintosh or PowerMac. A computer facility with CD-ROM drive and speakers is required.

Steps for running the program:

1. Make sure that your CD-ROM reader (in the case of an external player), computer and monitor are turned on.
2. Insert the CD-ROM into your CD Drive.
3. Open the CD-ROM by double-clicking its icon on the desktop.
4. Double-click the "Organ Transplantation' icon to start the multimedia application.